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Factors Affecting Highway Construction Projects in Iraq

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ABSTRACT

this paper aims to comprehensively detect the factors that exert influence on highway construction projects across the entirety of their lifecycle in Iraq. data were gathered via questionnaires distributed among 89 deliberately chosen participants hailing from construction enterprises, consulting establishments, and governmental bodies. By amalgamating pertinent existing literature, an assemblage of key factors impacting highway construction undertakings in Iraq was formulated. Subsequently, the collected data underwent systematic processing using the Statistical Package for the Social Sciences (SPSS) version 26. Employing a combination of descriptive analysis and the Relative Importance Index (RII), a hierarchical ordering of these identified factors was established. The results of this investigative endeavor spotlight 15 particularly pivotal and dominant factors that exert their influence on highway construction endeavors in Iraq. This assemblage encompasses dimensions such as meticulous site investigation, precision in design blueprints, resource availability, adherence to project specifications and quality benchmarks, and deployment of superior-quality materials aligning with stipulations, The results yielded by this inquiry stand poised to furnish project overseers and decision-makers with channeling their attention toward these pivotal factors to realize an elevated standard of excellence in road construction, consequently curbing long-term expenses.

Keywords: Factors, Highways construction projects, project management

INTRODUCTION

Highways are a specific kind of public route that links several municipalities. Highways play a key part in the growth of a nation since it is believed that infrastructures such as these have favorable correlations toward economic activity. This is because highways enable the speedy transportation of people and products to satisfy regional needs [1, 2]. In addition, when compared to other building projects, highway projects are often and always acknowledged as high-risk projects owing to the significance they have for the economic, sociological, and political growth of a country [3]. Although these projects are very visible to the general public, they are only considered to have been successful if and only if they were finished within the allotted time and budget, met the set goals and objectives, and caused minimum disturbances to the environment [4]. More than 44,000 kilometers of Iraq's roads are paved. The principal surface transportation connections linking Iraq to its neighbors are found within the country's extensive network of highways and bridges. An interconnected road network is beneficial to the nation since it encourages internal trade, helps the tourist industry, and links the country's population centers to important services[5].

Although guaranteeing the success of a project is very important, the progression of

highway construction projects may be slowed down by a number of problems. These include insufficient project financing and inadequate planning for the project[6]. Scholars hailing from diverse nationalities have been identifying the primary elements that have an impact on the local highway projects in their respective countries in order to get a comprehensive knowledge of the construction business in their respective countries [7-10].

The primary objective of this study is to thoroughly pinpoint and analyze the elements impacting Iraqi highway projects, The study intends to shed light on the obstacles that impede the advancement of such projects,

Literature Review

Many experts in highway transportation and construction project management have written extensively on a variety of highway-related topics. Multiple studies [7-10] have confirmed the importance of a small number of criteria in determining the final results of community highway projects. Late client payments, slow decision-making, and unfavorable weather are all examples of factors that have a significant impact on highway construction in Kenya [9]. Similar studies in Egypt have found that political unpredictability, and the propensity of project owners to award contracts to the cheapest bidder, are major factors in the country's construction industry [7]. Significant concerns impeding highway developments in Cambodia have been highlighted, including rain, floods, land acquisition difficulties, a bias for granting contracts to the lowest bidder, and equipment malfunctions[10].

Taken as a whole, these studies show how many variables interact to affect highway construction projects. There is a clear need to explore the variables affecting local highway projects [10],

This body of information has been supplemented by studies conducted in Malaysia, which have shed light on a set of characteristics affecting highway construction projects in the nation. These include the level of upper management involvement, client support, public acceptance, the competencies exhibited by project managers, The strategic site location, and so on [9]. Understanding regional effects is crucial for making educated decisions and carrying out local highway projects successfully, and the acknowledgment of these elements within the Malaysian context further supports this idea.

Researchers in Iraq have started investigating many different aspects of roadway construction. These studies look at a wide variety of factors, such as how contractors are chosen[11], how traffic is analyzed thereafter[12], and how modern, precision-driven cost calculation and optimization approaches are implemented[13-15]. Furthermore, a thorough investigation of sustainability criteria and its many facets hasbeen conducted[16].

It is important to note that delays continue to be a widespread issue across a wide range of projects due to a number of variables that prevent tasks from being completed on time [17, 18]. The foundational research by [19] identified seven main variables leading to delays within the context of road-building projects. These include the complicated interplay between political decisions and the current political landscape, the economic turbulence the country is experiencing, delays in the testing of materials and the subsequent acquisition of results, problems with paying contractors every month, problems with addressing delays in the implementation of the project, the significant impact of adverse weather conditions like rain and high temperatures, and finally, the lack of adequate funding for the project.

Methodology

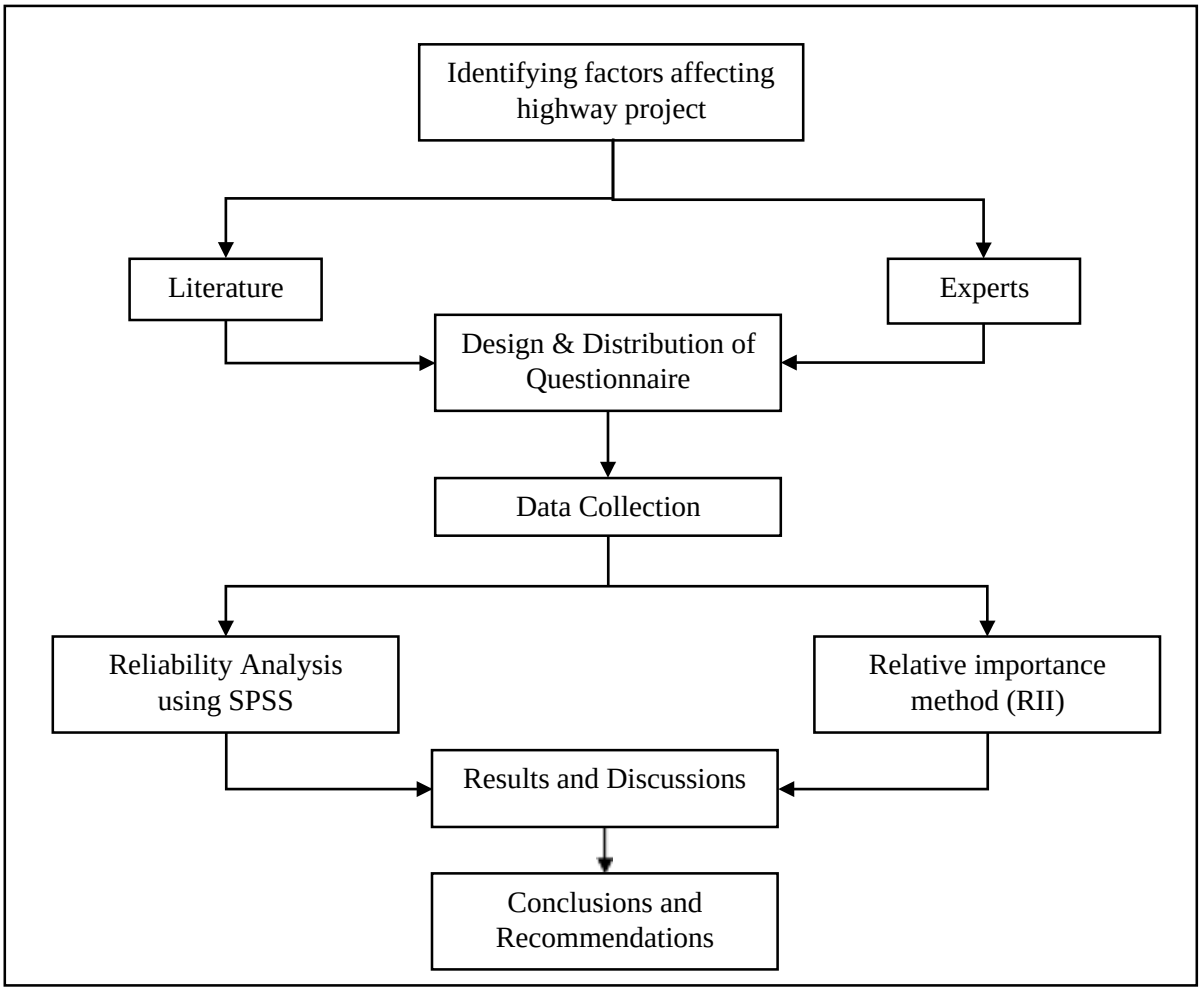

Figure 1 Research Methodology

Identifying Factors

Based on an extensive review of existing literature and insights from construction experts, it was evident that highway construction projects are influenced by a range of factors, which can vary in nature depending on the specific project. For this study. These influencing factors were systematically organized into seven primary categories

Furthermore, these categories were sub-divided into a total of 69 specific sub-factors, as outlined in detail in Table 4.

Questionnaire Design and Data Collection

To assess the influence of the aforementioned factors on highway construction projects, a structured questionnaire was crafted to elicit insights from experienced construction practitioners. [20] stated that surveys are widely used for data collection due to their ease of administration and straightforward data coding process. The questionnaire consisted of two distinct sections: First section gathered general details about the respondents, while Second section focused on the 69 factors known to impact highway construction projects, as delineated in Table 1.

Participants were requested to fill out a questionnaire that utilized a Likert scale consisting of five ordinal values ranging from 1 to 5. This scale gauged the frequency of occurrences (unimportant, low important, medium important, high important, very high important) for various factors, reflecting their respective levels of significance. The factors were methodically organized within the questionnaire.

Each factor's assessment was assigned a value on the Likert scale as follows:

Table 1 Five-point Likert scale for importance index

Scale	Degree of Important
1	Very less important
2	Less important
3	Medium Important
4	High Important
5	Very High Important

The survey was disseminated among a sample of over 100 professionals working in the construction industry using diverse channels; however, the final dataset consisted of responses from 89 individuals, who participated through platforms like Google Forms and personal interviews. The participant pool encompassed various Iraqi authorities, with a notable focus on the Public Authority for Roads and Bridges.

Data Analysis

The gathered responses underwent analysis through two distinct approaches:

1. The reliability of the acquired data was assessed to evaluate the internal consistency of the measurement scale employed for each factor. This assessment was conducted using SPSS software.
2. The factors influencing highway construction projects were ranked by employing the Relative Importance Index (RII) technique. This method facilitated the determination of the significance levels of these factors in the context of the study.

Analysis of Reliability

Data were collected separately from respondents who were affiliated with various institutions, ensuring the validity and reliability of the collected information becomes crucial. To evaluate reliability, a widely recognized measure known as Cronbach's alpha was employed. This metric is particularly suitable when a questionnaire includes multiple Likert scale questions. Using the SPSS software, a reliability test was carried out, revealing the intercorrelation among the various factors. In Figure 2, the reliability statistics data is presented. The calculated alpha value of 0.966 indicates a high level of data reliability.

Reliability statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.966	.963	69

Figure 2 Reliability statistics

Relative Importance Index

The Relative Importance Index (RII) is a statistical measure that condenses the significance of factors as contributors to disparities in viewpoints. RII is valuable because it accounts for both the population size and the relative variations in their opinions[21]. To establish the hierarchy of various factors, the Relative Importance Index (RII) was calculated using the formula depicted in Equation 1.

$$RII = \frac{\sum_{i=0}^{i=A} n_i * I}{A * N} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{A * N} \quad \ldots\ldots\ldots (1)$$

Where,

RII = Relative Importance Index

n = Respondents selecting options

N = Total Respondents

I = Individual responses (i.e., 1, 2, 3, 4, 5)

A = Highest response (i.e., 5)

Results and Discussion of Findings

Table 2 Academic achievement.

Academic achievement	Number of respondents	Percentage response rate %
Bachelor	52	58.4
High Diploma	4	4.5
Master	23	25.8

Doctorate	10	11.2
Total	89	100.0

Table 3 Respondent experience.

Experience	Number of respondents	Percentage response rate %
5-10 years	25	28.1
10-20 years	34	38.2
More than 20 years.	30	33.7
Total	89	100.0

Results& Findings

The successful implementation of highway construction projects in Iraq is influenced by a multitude of interconnected factors, each contributing to varying degrees of importance. Analyzing and prioritizing these factors based on the Relative Importance Index (RII) scores provides valuable insights into their significance and impact on highway construction projects in Iraq.

Table 4 Main categories and sub-factors

Factors	**1**	**2**	**3**	**4**	**5**	**RII**
Pre-project implementation factors						
Site investigation and determine the route path	0	0	1	21	67	0.948
Design drawings/ review	0	0	4	19	66	0.939
Sufficient time for feasibility studies, design, drawings, and tender preparation	0	0	3	26	60	0.928
Preparing clear estimation/bills of quantities	0	0	2	32	55	0.919
Preparing adequate and comprehensive specifications	0	0	6	31	52	0.903
Land acquisition and clearing right of way obstructions	0	0	8	34	47	0.888

Traffic flow analysis (data related to traffic volume, composition, and expected growth)	0	1	12	32	44	0.867
Adequate project planning and scheduling	0	0	12	38	39	0.861
Accurate initial cost estimates	0	0	12	43	34	0.849
Contract negotiation and Correct identification of the best-evaluated bidder	0	1	13	39	36	0.847
Logistic management	1	1	19	40	28	0.809
Project management factors						
Participation of senior management	0	0	6	43	40	0.876
Effective scheduling and time control system and frequency of project schedule updates	0	1	10	36	42	0.867
Implementing an effective quality control and assurance systems	0	0	11	38	40	0.865
Effective cost control system and frequency of project budget updates	0	0	10	46	33	0.852
Implementing an effective safety program	1	2	17	23	46	0.849
Dispute resolution and conflict management	0	3	10	43	33	0.838
Establish a risk management system that clarifies the risk identification and allocation	1	2	16	37	33	0.822
Financial risk management	1	2	15	43	28	0.813
Frequent meetings among various stakeholders to evaluate the overall performance and report updates	2	2	19	35	31	0.804
Resource allocation and optimization	1	2	19	39	28	0.804
Support from clients	0	4	16	45	24	0.800
Stakeholder factors						
Competencies of project managers and Ability to make timely decision	0	1	5	29	54	0.906
Impact of execution parties (contractors, consultants, subcontractors, engineers, suppliers, laborers)	0	1	9	34	45	0.876
Efficiency of authorities	0	0	18	33	38	0.845
Impact of client authorities (financial, inspection, political leaders)	1	1	15	36	36	0.836
Adequate communication among project stakeholders	1	1	14	44	29	0.822
Impact of government institutions	1	1	17	39	31	0.820
Public acceptance, and Community beneficiaries	1	1	15	44	28	0.818
Setting out communication channels within the project team and other stakeholders	0	1	19	42	27	0.813
Clearly identified the formal relationships among project parties, as well as the roles and responsibilities in the contract	0	2	16	47	24	0.809
Impact of landowners	1	1	21	38	28	0.804
Negotiations with stakeholders in a bid to build consensus	0	0	25	38	26	0.802

Resources factors						
Availability of skilled workforce, materials, equipment	0	0	2	23	64	0.939
Good quality material and according to specifications	0	2	1	23	63	0.930
Competency and technical skills	0	1	2	28	58	0.921
Material testing and quality assurance	0	0	7	25	57	0.912
Continuity of resources supply	0	0	6	30	53	0.906
Good equipment quality	0	0	6	36	47	0.892
Total years of (construction, project management) experience	0	0	7	40	42	0.879
Equipment productivity at work	0	1	5	41	42	0.879
Delivery of materials on time according to schedule	0	1	10	31	47	0.879
Equipment maintenance on a regular basis	0	1	12	42	34	0.845
Safety and risk factors						
Accidents and traffic safety management	1	0	5	23	60	0.917
Natural /External risks (Floods/earthquake, technological changes)	0	0	9	24	56	0.906
Site Security	0	1	8	28	52	0.894
Compliance with the code principles and international standards.	0	0	7	34	48	0.892
delays in progress payment by owners	0	2	10	33	44	0.867
Personnel risks (Lack of skills and experience)	1	0	14	30	44	0.861
Variation orders	0	1	14	35	39	0.852
Government regulations and political factors	0	1	18	41	29	0.820
Inflation	1	0	19	40	29	0.816
Errors in designs	1	4	16	36	32	0.811
Disputes between laborers	1	7	25	37	19	0.748
Environmental factors						
Impact of weather conditions on a project	1	5	17	33	33	0.807
Environment social impact assessment to understand the impact of the project on the host community	1	5	14	40	29	0.804
Environmental permitting and compliance	3	4	16	33	33	0.800
Carbon footprint reduction strategies and green infrastructure integration	1	11	11	36	30	0.787
Ecological impact assessment and mitigation measures	2	3	24	34	26	0.778
Sustainable construction practices	2	6	18	37	26	0.778
Noise pollution	3	6	20	30	30	0.775
Waste management and disposal practices	2	6	18	39	24	0.773
Air and water quality	3	6	21	33	26	0.764
Energy efficiency considerations	2	13	12	38	24	0.755
Environmental factors						
The project meets specifications and quality standards	0	0	5	20	64	0.933
Projects are completed on time	0	0	8	26	55	0.906
Projects are usually undertaken within budgeted costs	0	2	6	34	47	0.883

Safety record and incident management	1	4	12	32	40	0.838
Stakeholder satisfaction and feedback	1	5	14	38	31	0.809

Table 5 Overall ranked factors affecting highway construction projects

Factors	**RII**	**Rank**
Site investigation and determine route path	0.948	1
Design drawings/ review	0.939	2
Availability of skilled workforce, materials, equipment	0.939	3
The project meets specifications and quality standards	0.933	4
Good quality material and according to specifications	0.930	5
Adequate time allocation for conducting feasibility studies, developing designs, creating drawings, and preparing tenders.	0.928	6
Competency and technical skills	0.921	7
Preparing clear estimation/bills of quantities	0.919	8
Accidents and traffic safety management	0.917	9
Material testing and quality assurance	0.912	10
Competencies of project managers and Ability to make timely decision	0.906	11
Continuity of resources supply	0.906	12
Natural /External risks (Floods/earthquake, technological changes)	0.906	13
Projects are completed on time	0.906	14
Preparing adequate and comprehensive specifications	0.903	15
Site Security	0.894	16
Good equipment quality	0.892	17
Compliance with the code principles and international standards	0.892	18

Land acquisition and clearing right of way obstructions	0.888	19
Projects are usually undertaken within budgeted costs	0.883	20
Total years of (construction, project management) experience	0.879	21
Equipment productivity at work	0.879	22
Delivery of materials on time according to schedule	0.879	23
Participation of senior management	0.876	24
Impact of execution parties (contractors, consultants, subcontractors, engineers, suppliers, laborers)	0.876	25
Effective scheduling and time control system and frequency of project schedule updates	0.867	26
Delays in progress payment by owners	0.867	27
Putting in place efficient systems for controlling and ensuring quality	0.865	28
Adequate project planning and scheduling	0.861	29
Personnel risks (Lack of skills and experience)	0.861	30
Efficient cost management system and frequency of project budget revisions	0.852	31
Variation orders	0.852	32
Accurate initial cost estimates	0.849	33
Implementing an effective safety program	0.849	34
Contract negotiation and Correct identification of the best-evaluated bidder	0.847	35
Efficiency of authorities	0.845	36
Equipment maintenance on a regular basis	0.845	37
Dispute resolution and conflict management	0.838	38
Safety record and incident management	0.838	39

Impact of client authorities (financial, inspection, political leaders)	0.836	40
Establish a risk management system that clarifies the risk identification and allocation	0.822	41
Adequate communication among project stakeholders	0.822	42
Impact of government institutions	0.820	43
Government regulations and political factors	0.820	44
Public acceptance, and Community beneficiaries	0.818	45
Inflation	0.816	46
Financial risk management	0.813	47
Setting out communication channels within the project team and other stakeholders	0.813	48
Impact (economic, social)	0.811	49
Errors in designs	0.811	50
Logistic management	0.809	51
Clearly identified the formal relationships among project parties, as well as the roles and responsibilities in the contract	0.809	52
Stakeholder satisfaction and feedback	0.809	53
Impact of weather conditions on a project	0.807	54
Frequent meetings among various stakeholders to evaluate the overall performance and report updates	0.804	55
Resource allocation and optimization	0.804	56
Impact of landowners	0.804	57
environment social impact assessment to understand the impact of the project on the host community	0.804	58
Negotiations with stakeholders in a bid to build consensus	0.802	59

Support from clients	0.800	60
Environmental permitting and compliance	0.800	61
Carbon footprint reduction strategies and green infrastructure integration	0.787	62
Ecological impact assessment and mitigation measures	0.778	63
Sustainable construction practices	0.778	64
Noise pollution	0.775	65
Waste management and disposal practices	0.773	66
Air and water quality	0.764	67
Energy efficiency considerations	0.755	68
Disputes between laborers	0.748	69

Conclusion and Recommendations

In the context of highway construction projects in Iraq, the multifaceted nature of factors influencing these endeavors becomes evident. These factors span across a diverse spectrum, encapsulating Pre-project Implementation Factors, Project Management Factors, Stakeholder Factors, Resources Factors, Safety and Risk Factors, Environmental Factors, and Project Performance. To holistically evaluate project performance, it is imperative to recognize and integrate these dimensions.

Throughout the lifecycle of highway construction projects, a complex interplay of factors comes into play. This study undertook a comprehensive exploration, meticulously identifying and evaluating these diverse factors across various aspects within the Iraqi context. A thorough analysis was conducted, encompassing a comprehensive list of 69 factors that impact highway construction projects from inception to completion. Inclusivity and accuracy were ensured through engagement with stakeholders from Iraq's construction sector, whose invaluable insights were rigorously analyzed to identify the most significant factors.

At the forefront of these determinants are factors such as site investigation and route path determination, design drawings/review, and the availability of a skilled workforce, materials, and equipment. Adherence to project specifications and quality standards, along with the utilization of high-quality materials in alignment with specifications, emerged as pivotal factors. Moreover, the study underscored the significance of allowing ample time for feasibility studies, nurturing competency and technical skills, ensuring clear estimation/bills of quantities, and prioritizing accidents and traffic safety management.

In addition, factors such as material testing, quality assurance, project manager

competencies, and the continuity of resource supply were identified as vital contributors to project success. Furthermore, the study highlighted the role of competent decision-making by project managers and the management of external risks such as natural disasters and technological changes.

The highlighted critical factors underscore the importance of detailed planning, resource efficiency,safety measures, and skill development. To ensure project success amidst these challenges, adopt the following recommendations:

1- Integrating planning processes with comprehensive feasibility studies and accurate cost estimations holds immense value. This synergy ensures that decisions are grounded in well-researched data, minimizing uncertainties, and optimizing project planning. This approach is pivotal because it enhances the overall project predictability, reduces the risk of budget overruns, and facilitates resource allocation based on informed projections.
2- Strategic resource allocation is a cornerstone of successful highway construction. By focusing on factors such as a skilled workforce, materials, and equipment availability, you can ensure that resources are allocated where they are most needed, thus maximizing efficiency. Additionally, implementing resource continuity planning prevents potential bottlenecks, minimizes project disruptions, and maintains a consistent workflow. This approach guarantees that the project progresses smoothly and remains on schedule.
3- Prioritizing safety measures is not only ethically essential but also operationally crucial. A safe working environment safeguards the well-being of your workforce and enhances project morale. Furthermore, an effective risk management strategy, encompassing both on-site and external risks, is essential. This proactive approach minimizes the potential impact of unforeseen events, ensuring project continuity and preserving the project's financial and timeline commitments.
4- Investing in the development of competencies among project managers and teams is an investment in the project's success. Enhanced technical skills and decision-making abilities enable smoother project execution, effective problem-solving, and efficient resource management. With timely and informed decision-making, potential bottlenecks are addressed swiftly, preventing delays and ensuring that the project stays on track. This competency-driven approach is instrumental in optimizing project outcomes.

By implementing these recommendations, a comprehensive strategy is adopted that encompasses various dimensions of highway construction. Each point plays a pivotal role, contributing significantly to enhanced project efficiency, minimized risks, improved safety measures, and, ultimately, the successful completion of highway construction projects within Iraq's evolving construction environment.

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